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Energy, Impurity and Particle Transport in Quiescent Double Barrier Discharges in DIII-D[1]

W.P. WEST, General Atomics

Quiescent double barrier discharges (QDB) on DIII-D exhibit near steady high performance ($\beta_N \mathrm{H} \lesssim 7$) with an ELM-free H-mode edge but effective particle control and strongly peaked density profiles. Increased retention of high-Z impurities is observed as anticipated by neoclassical theory, and core nickel concentrations (an intrinsic impurity in DIII-D) as high as 0.3% are observed. To quantify impurity transport, trace impurity injection has been performed in steady QDB discharges and analysis shows a fast influx followed by a slow pump out. The measured decay times of the core concentration of two non-recycling impurities, F (Z=9) and Ca (Z=22), are 327 and 670 ms respectively, while the energy confinement time is 125 ms. This increase of impurity confinement time with Z is characteristic of neoclassical models. Detailed analysis of the impurity transport, from the measured temporal and spatial evolution of the impurities, will be compared with neoclassical models. These QDB discharges also exhibit an internal transport barrier with low ion thermal transport despite incomplete turbulence suppression. Very short correlation lengths, which reduce the transport step size, however, characterize the residual turbulence. This observation is consistent with simulations using the GLF23 model, which reproduce the core ion temperature profile even in the presence of finite turbulence. The boundary of these discharges is characterized by a saturated coherent MHD mode, the edge harmonic oscillation, which takes the place of ELMs in facilitating particle control by allowing particle transport to the open field lines, where both wall- and cryopumping play a major role in particle exhaust. Hot (>1 keV) ions observed in the outer SOL might enhance wall pumping.

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